10:40:42 OCA PAD AMENDMENT - PROJECT HEADER INFORMATION 01/18/96

Active

Project #: E-25-T61 Cost share #: Rev #: 2
Center # : 10/24-6-R8571-0A0 Center shr #: OCA file #:
Work type : RES
Contract#: DMI-9596172 Mod #: OPAS Document : GRANT
Prime #: Contract entity: GTRC

Subprojects ? : N CFDA: 47.041
Main project #: PE #: N/A

Project unit: MECH ENGR Unit code: 02.010.126
Project director(s):
KURFESS T R MECH ENGR (404)894-0301

Sponsor/division names: NATL SCIENCE FOUNDATION / GENERAL
Sponsor/division codes: 107 / 000

Award period: 950501 to 970228 (performance) 970531 (reports)

Sponsor amount	New this change	Total to date
Contract value	0.00	28,285.00
Funded	0.00	28,285.00
Cost sharing amount		0.00

Does subcontracting plan apply ?: N

Title: STATISTICAL INFERENCE ON PART GEOMETRY

PROJECT ADMINISTRATION DATA

OCA contact: Jacquelyn L. Bendall 894-4820

Sponsor technical contact

PIUS J. EGBELU
(703)306-1328

NATIONAL SCIENCE FOUNDATION
4201 WILSON BLVD.
ARLINGTON, VA 22230

Sponsor issuing office

HERBERT D. WOLFF, III
(703)306-1218

NATIONAL SCIENCE FOUNDATION
4201 WILSON BLVD.
ARLINGTON, VA 22230

Security class (U,C,S,TS) : U ONR resident rep. is ACO (Y/N): N
Defense priority rating : N/A NSF supplemental sheet
Equipment title vests with: Sponsor GIT X
NONE PROPOSED
Administrative comments -
ISSUED TO EXTEND PROJECT TERMINATION DATE TO 2-28-97 WITH THE FINAL REPORT DUE 5-31-97.

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

4

NOTICE OF PROJECT CLOSEOUT

Closeout Notice Date 03/03/97

Project No. E-25-T61_____ Center No. 10/24-6-R8571-0A0_

Project Director KURFESS T R_____ School/Lab MECH ENGR_____

Sponsor NATL SCIENCE FOUNDATION/GENERAL_____

Contract/Grant No. DMI-9596172_____ Contract Entity GTRC

Prime Contract No. _____

Title STATISTICAL INFERENCE ON PART GEOMETRY_____

Effective Completion Date 970228 (Performance) 970531 (Reports)

Closeout Actions Required:	Y/N	Date Submitted
Final Invoice or Copy of Final Invoice	N	_____
Final Report of Inventions and/or Subcontracts	N	_____
Government Property Inventory & Related Certificate	N	_____
Classified Material Certificate	N	_____
Release and Assignment	N	_____
Other _____	N	_____

Comments_____
LETTER OF CREDIT APPLIES. 98A SATISFIES PATENT REPORT._____

Subproject Under Main Project No. _____

Continues Project No. _____

Distribution Required:

Project Director	Y
Administrative Network Representative	Y
GTRI Accounting/Grants and Contracts	Y
Procurement/Supply Services	Y
Research Property Managment	Y
Research Security Services	N
Reports Coordinator (OCA)	Y
GTRC	Y
Project File	Y
Other _____	N
_____	N

E-25-T61 #1

OMB Number 345-0058

NATIONAL SCIENCE FOUNDATION
4201 Wilson Blvd.,
Arlington, VA 22230

BULK RATE
POSTAGE & FEES PAID
National Science Foundation
Permit No. G-69

PI/PD Name and Address

Thomas R. Kurfess
Department of Mechanical Engineering
GA Tech Res Corp - GIT
School of Mechanical Engineering
Atlanta GA 30332-0405

NATIONAL SCIENCE FOUNDATION
FINAL PROJECT REPORT

PART I - PROJECT IDENTIFICATION INFORMATION

1. Program Official/Org. M. Christina Gabriel - DMI

2. Program Name OPERATIONS RESEARCH & PRODUCTION SYSTEMS

3. Award Dates (MM/YY) From: 05/95 To: 02/96

4. Institution and Address
GA Tech Res Corp - GIT
Administration Building
Atlanta GA 30332

5. Award Number 9596172

6. Project Title
Statistical Inference on Part Geometry

This Packet Contains
NSF Form 98A
And 1 Return Envelope

PART IV -- FINAL PROJECT REPORT -- SUMMARY DATA ON PROJECT PERSONNEL

(To be submitted to cognizant Program Officer upon completion of project)

The data requested below are important for the development of a statistical profile on the personnel supported by Federal grants. The information on this part is solicited in resonse to Public Law 99-383 and 42 USC 1885C. All information provided will be treated as confidential and will be safeguarded in accordance with the provisions of the Privacy Act of 1974. You should submit a single copy of this part with each final project report. However, submission of the requested information is not mandatory and is not a precondition of future award(s). Check the "Decline to Provide Information" box below if you do not wish to provide the nformation.

Please enter the numbers of individuals supported under this grant.
Do not enter information for individuals working less than 40 hours in any calendar year.

	Senior Staff		Post-Doctorals		Graduate Students		Under-Graduates		Other Participants[1]	
	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.
A. Total, U.S. Citizens	2						3	4		
B. Total, Permanent Residents										
U.S. Citizens or Permanent Residents[2]:										
American Indian or Alaskan Native										
Asian.....								1		
Black, Not of Hispanic Origin.....							1			
Hispanic										
Pacific Islander										
White, Not of Hispanic Origin	2						2	3		
C. Total, Other Non-U.S. Citizens					2					
Specify Country										
1. KOREA					1					
2. FRANCE					1					
3.										
D. Total, All participants (A + B + C)	2				2		3	4		
Disabled[3]										

☐ Decline to Provide Information: Check box if you do not wish to provide this information (you are still required to return this page along with Parts I-III).

[1] Category includes, for example, college and precollege teachers, conference and workshop participants.

[2] Use the category that best describes the ethnic/racial status fo all U.S. Citizens and Non-citizens with Permanent Residency. *(If more than one category applies, use the one category that most closely reflects the person's recognition in the community.)*

[3] A person having a physical or mental impairment that substantially limits one or more major life activities; who has a record of such impairment; or who is regarded as having such impairment. *(Disabled individuals also should be counted under the appropriate ethnic/racial group unless they are classified as "Other Non-U.S. Citizens.")*

AMERICAN INDIAN OR ALASKAN NATIVE: A person having origins in any of the original peoples of North America and who maintains cultural identification through tribal affiliation or community recognition.

ASIAN: A person having origins in any of the original peoples of East Asia, Southeast Asia or the Indian subcontinent. This area includes, for example, China, India, Indonesia, Japan, Korea and Vietnam.

BLACK, NOT OF HISPANIC ORIGIN: A person having origins in any of the black racial groups of Africa.

HISPANIC: A person of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish culture or origin, regardless of race.

PACIFIC ISLANDER: A person having origins in any of the original peoples of Hawaii; the U.S. Pacific territories of Guam, American Samoa, and the Northern Marinas; the U.S. Trust Territory of Palau; the islands of Micronesia and Melanesia; or the Philippines.

WHITE, NOT OF HISPANIC ORIGIN: A person having origins in any of the original peoples of Europe, North Africa, or the Middle East.

PART II SUMMARY OF COMPLETED PROJECT

The research that was conducted with the support of this grant addressed quality assurance issues from a statistical analysis perspective. We concentrated our efforts in two specific areas as outlined in our proposal: *i*) multivariate statistical analysis of coordinate measurement machine data for confidence interval calculation on part inspection, and *ii*) estimation of part quality by determination of minimum zone fit for coordinate measurement machine data. The second effort has resulted in some excellent collaboration with the Aluminum Company of America (Alcoa), the Timken Company and Brown & Sharpe, and has yielded a new set of algorithms for geometric analysis that are substantially faster and more efficient than other approaches.

One of the two major results of this project include a statistical quantification of confidence intervals for estimated part geometry using least squares fitting approaches with data taken by coordinate measurement machines. This capability has permitted a number of companies to determine that their quality assurance programs are not providing reliable results. To address these unreliable results, we have begun the development of an inspection planning system that utilizes the results of this project to minimize the confidence intervals on inspections via point sampling strategies. The second major result of this project is the development of a generic minimum zone fitting algorithm. This highly efficient algorithm is currently being evaluated by several corporations for its use in determining assembly tolerance validation.

PART III LIST OF PUBLICATIONS

Vasseur, H., Cagan, J., Kurfess, T. R., "Quality Innovation in Design and Manufacturing: an Economic Model," *Manufacturing Review*, December 1993, Vol. 6, No. 4, pp. 343-352.

Kurfess, T. R., Banks, D. L., "Statistical Verification of Part Geometry," Computer-Aided Design, May 1995, Vol. 27, No. 5, pp. 353-361.

Kurfess, T. R., D. L. Banks, Wolfson, J. J., "A Multivariate Statistical Approach to Metrology," *ASME Journal of Engineering for Industry*, accepted.

Vasseur, H., Cagan, J., Kurfess, T. R., "Use of a Quality Loss Function to Select Statistical Tolerances," *ASME Journal of Engineering for Industry*, accepted.

Vasseur, H., Kurfess, T. R., Cagan, J., "Optimal Tolerance Allocation for Improved Productivity," *Proceedings of the International Federation of Automatic Control Workshop, Automatic Control for Quality and Productivity*, Vol. 1, pp. 211-218, Istanbul, Turkey, June, 1992.

Vasseur, H., Kurfess, T. R., Cagan, J., "A Decision-Analytic Method for Competitive Design for Quality," *Proceedings of the ASME Design Automation Conference, Advances in Design Automation, Optimum Design, Manufacturing Processes and Concurrent Engineering*, DE-Vol. 44-1, pp. 329-336, Phoenix, AZ, September, 1992.

Cagan, J., Kurfess, T. R., "Optimal Tolerance Allocation over Multiple Manufacturing Alternatives," *Proceedings of the ASME Design Automation Conference, Advances in Design Automation, Geometric Modeling, Mechanisms and Mechanical Systems Analysis*, DE-Vol. 44-2, pp. 165-172, Phoenix, AZ, September, 1992.

Choi, W., Kurfess, T. R., "Data Localization Algorithms for Automated Inspection," *Advances in Design Automation, ASME Design Automation Conference*, Vol. DE-65-2, pp. 1-6, Albuquerque, NM, September, 1993.

Vasseur, H., Kurfess, T. R., Cagan, J., "An Economic Analysis of Quality Innovation in Design and Manufacturing" *Advances in Design Automation, ASME Design Automation Conference*, Vol. DE-65-2, pp. 495-500, Albuquerque, NM, September, 1993.

Banks, D. L., Kurfess, T. R., Wolfson, L. J. "Assessing Conformance to Geometric Tolerance," *The Annual Meeting of the American Statistical Association*, invited paper, Toronto, Canada, August, 1994.

Kurfess, T. R., Banks, D. L., "Statistical Verification of Conformance to Geometric Tolerance," *ASME Design Automation Conference, Minneapolis*, MN September, 1994.

Anderson, R.N., Kurfess, T.R., Fussell, P.S., and Hulting, F.L., "Characterization of Aluminum Extrusion Cross Sections," *1994 International Mechanical Engineering Congress and Exposition*, PED-Vol. 68-1, pp. 203-210, Chicago, IL, November 1994.

Vasseur, H., Kurfess, T.R. and Cagan, J. "Influence of Inspection Strategy on Manufacturing Process Selection," *1994 International Mechanical Engineering Congress and Exposition*, DE-Vol. 74, pp. 185-195, Chicago, IL, November 1994.

Choi, W. and Kurfess, T.R. "Data Localization Algorithms and Minimum Zone Evaluations for Automated Inspection," *1994 International Mechanical Engineering Congress and Exposition*, DE-Vol. 74, pp. 39-46, Chicago, IL, November 1994.

Kurfess, T.R., Banks, D.L., and Wolfson, L.J., "Statistical Metrology," *1994 International Mechanical Engineering Congress and Exposition*, DSC-Vol. 55-2, pp. 961-967, Chicago, IL, November 1994.

Gallagher, C.T., and Kurfess, T.R., "Development of a High Speed Inspection System for Prismatic Metallic Parts," *1994 International Mechanical Engineering Congress and Exposition*, DSC-Vol. 55-2, pp. 909-914, Chicago, IL, November 1994.

Choi, W., Kurfess, T.R., "Dimensional Measurement Data Analysis Part I, a Zone Fitting Algorithm," *1995 International Mechanical Engineering Congress and Exposition*, to be presented, Atlanta, GA, November 1996, submitted.

Choi, W., Kurfess, T.R., "Dimensional Measurement Data Analysis Part II, Minimum Zone evaluation," *1995 International Mechanical Engineering Congress and Exposition*, to be presented, Atlanta, GA, November 1996, submitted.

Vassuer, H., *Manufacturing Quality and Process Precision: A Cost-Based Analysis* Department of Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA, 1996.

Choi, W., *Computational Analysis of Three Dimensional Measurement Data* Ph.D. Dissertation, Department of Mechanical Engineering, Carnegie Mellon University, Pittsburgh, PA, 1996.